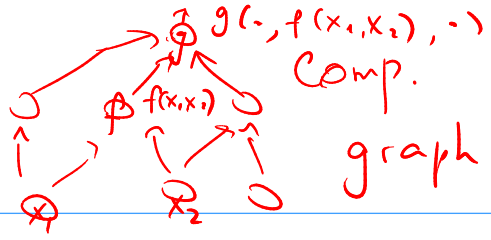
$\ln p(\bar{w}|D) \to \max_{\bar{w}}$

$\ln p(D|\bar{w}) \to \max_{\bar{w}}$

optimization



Comp. graph

$$p(x|D) = \int p(x|\bar{w})\, p(\bar{w}|D)\, d\bar{w}$$

$$f(\bar{w}) \to \min$$

$$\bar{w} := \bar{w} - \eta \nabla_{\bar{w}} f$$

$f = de = (x_1+w_2)^2 (x_1 w_1 + x_2 w_2)$

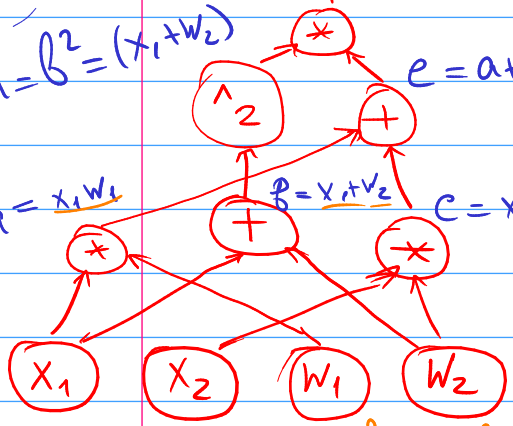
$d = b^2 = (x_1+w_2)^2$

$e = a+c = x_1 w_1 + x_2 w_2$

$a = x_1 w_1$

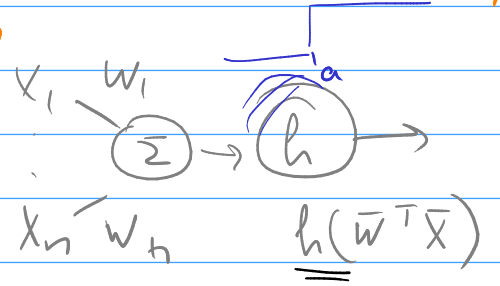
$b = x_1 + w_2$

$c = x_2 w_2$



$\frac{\partial f}{\partial w_2} = d\frac{\partial e}{\partial w_2} + e\frac{\partial d}{\partial w_2} = x_2(x_1+w_2)^2 + 2(x_1w_1+x_2w_2)(x_1+w_2)$

forward propagation



$h(\bar{w}^T \bar{x})$

$\frac{\partial d}{\partial w_2} = 2b\frac{\partial b}{\partial w_2} = 2b = 2(x_1+w_2)$

$\frac{\partial e}{\partial w_2} = \frac{\partial a}{\partial w_2} + \frac{\partial c}{\partial w_2} = x_2$

$\frac{\partial a}{\partial w_2} = 0$

$\frac{\partial b}{\partial w_2} = \frac{\partial x_1}{\partial w_2} + \frac{\partial w_2}{\partial w_2} = 1$

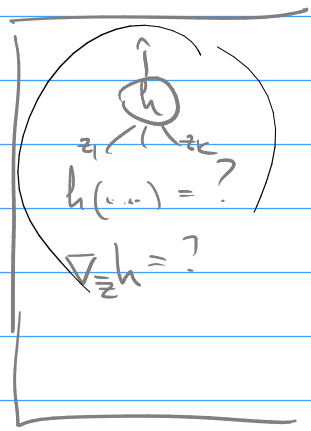
$\frac{\partial c}{\partial w_2} = x_2$

$y = \begin{cases} 1, & \bar{w}^T\bar{x} \geq a \\ 0, & \bar{w}^T\bar{x} < a \end{cases}$

$\frac{\partial x_1}{\partial w_2} = 0$

$\frac{\partial w_2}{\partial w_2} = 1$

$x_2 = -1$



backpropagation

pyTorch
Tensorflow
caffe
theano

$f = de$

$\frac{\partial f}{\partial f} = 1$

$\frac{\partial f}{\partial d} = e$

$\frac{\partial f}{\partial e} = d$

$d = b^2$

$e = a+c$

$\frac{\partial f}{\partial a} = \frac{\partial f}{\partial e} = d$

$a = x_1 w_1$

$\frac{\partial f}{\partial b} = \frac{\partial f}{\partial d}\frac{\partial d}{\partial b} = 2be$

$\frac{\partial f}{\partial c} = \frac{\partial f}{\partial e}\frac{\partial e}{\partial c} = d$

$\frac{\partial f}{\partial x_1} = \frac{\partial f}{\partial a}\frac{\partial a}{\partial x_1} + \frac{\partial f}{\partial b}\frac{\partial b}{\partial x_1} = d \cdot w_1 + 2be$

$\frac{\partial f}{\partial x_2} = \frac{\partial f}{\partial c}\frac{\partial c}{\partial x_2} = d \cdot w_2$

$\frac{\partial f}{\partial w_1} = \frac{\partial f}{\partial a}\frac{\partial a}{\partial w_1} = d \cdot x_1$

$\frac{\partial f}{\partial w_2} = \frac{\partial f}{\partial b}\frac{\partial b}{\partial w_2} + \frac{\partial f}{\partial c}\frac{\partial c}{\partial w_2} = 2be + d \cdot x_2$

$\nabla_{\bar{w}} f$